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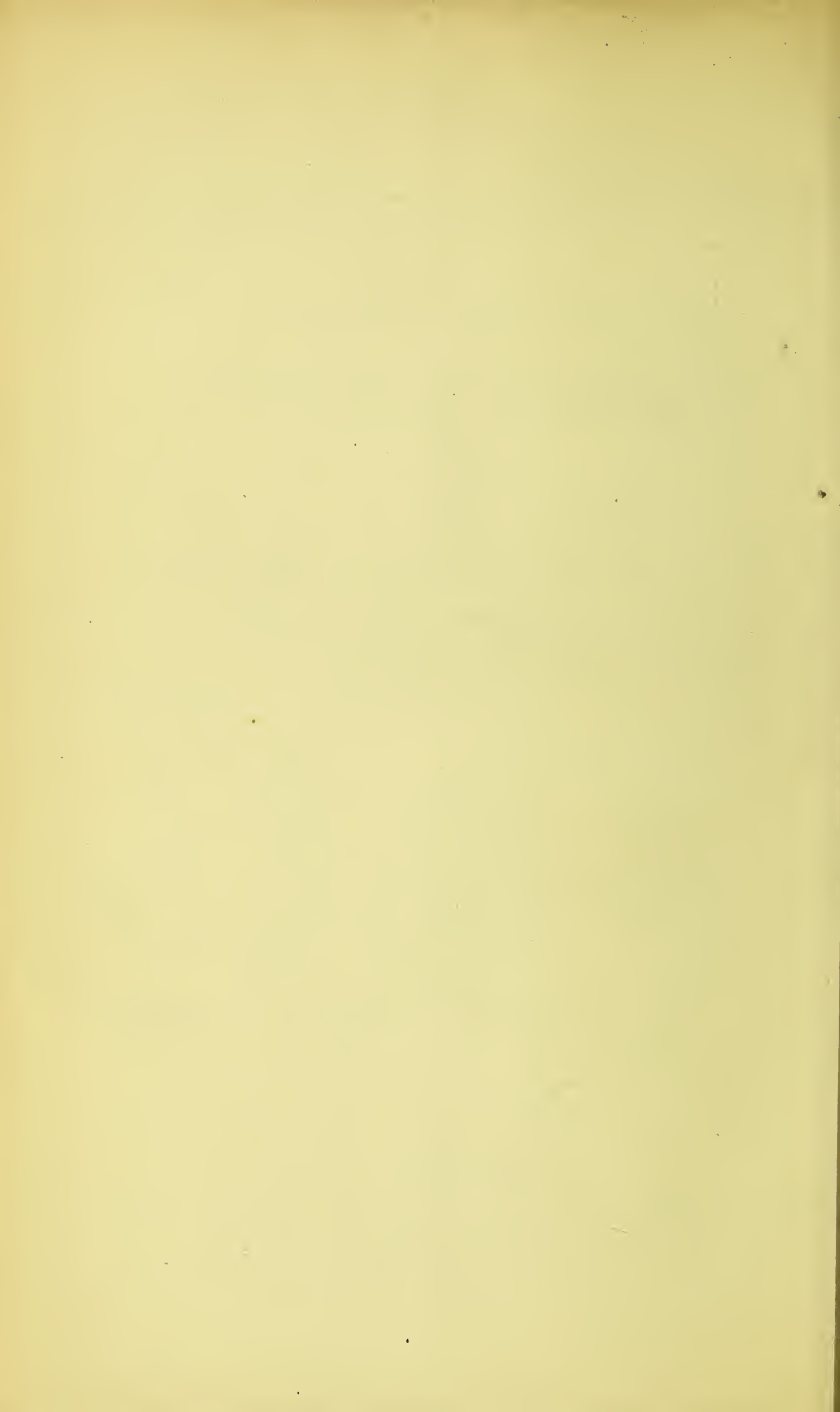
ON THE *From the Author.*
ENDEMIC HÆMATURIA OF HOT CLIMATES

CAUSED BY THE PRESENCE OF
BILHARZIA HÆMATOBIA.

BY
F. H. H. GUILLEMARD, M.A., M.D.,
GONVILLE AND CAIUS COLLEGE, CAMBRIDGE.
FELLOW OF THE ROYAL GEOGRAPHICAL SOCIETY.



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F. H. H. G.

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ENDEMIC TROPICAL HÆMATURIA.



CHAPTER I.

TYPE CASE.

WHILE travelling in Africa in the years 1877-78 I came across, among others, the following case of parasitic Hæmaturia. As these cases are so very rarely seen in Europe, and our knowledge of them necessarily so limited, I have thought it possibly not unworthy of detailed consideration—more especially from the fact that in this instance I have been fortunately enabled to watch the case from the very outset.

A. B., age 29, health previously good, was travelling in 1877-78 in and beyond the district of Limpopo river, South Central Africa. He was a good deal pulled down by an attack of malarial fever in the January of the latter year, followed by enteric fever immediately afterwards. From this he made a fair recovery, but at the end of April, while

Sudden
onset.

in the south of the Bechuana country, he was one day suddenly seized with sharp pain in the urethra while passing water. From that time micturition was constantly attended with pain, which gradually increased in severity; but, with the exception of occasional sharp pain in the perinæum at other times, and a rather more frequent desire to pass water, there was no other apparent symptom. On reaching the Diamond Fields in June he was some 16 lb. below his ordinary weight, and was anæmic, but still able to undergo considerable exertion. Here his urine was first examined. It was clear and free from albumen, but contained numerous specks, about the size of a pin's head, of a bright scarlet colour. Microscopic examination revealed a few blood-corpuscles, pus-cells, and the unmistakable ova of the Bilharzia.

Hæmaturia.

While coming down by waggon to the coast at the end of June, 1878—rather more than two months after the onset of the first symptoms—he first noticed the presence of blood in the urine, the amount being limited to a few drops immediately after micturition. By this time the irritability of the bladder had ceased, but not so the pain caused by emptying that organ, and the patient got into the habit of only passing water once daily in consequence. On his arrival at Durban, however, there was a marked improvement in his case, which

continued throughout his voyage to England; and on landing in this country he felt almost in his ordinary state of health, though the slight hæmaturia persisted.

After consulting Dr. John Harley it was arranged that topical medication of the bladder with iodide of potassium should be tried, and accordingly, on September 1st, about 3 oz. of a solution of 1 gr. to the ounce were injected. At the time of the operation it was noticed that the lips of the urethral orifice were somewhat injected and swollen, and that certain portions of the perinæum and under part of the penis were slightly tender on pressure. The passage of the catheter was attended with extreme pain.

The result was most unfortunate. On the following morning the patient had complete loss of appetite, headache, and rigors, with severe pain over the region of the kidneys. No urine was passed till the evening, when two or three ounces, bloody, and containing about one-third albumen, were voided. Next day, September 3rd, acute cystitis appeared.

Topical
medication
of bladder
resolved on.

Its result
acute ne-
phritis and
cystitis.

From this time until the middle of May, 1879, a period of nearly nine months, the patient was entirely confined to his room. After the first month the symptoms of acute inflammation of the bladder had disappeared, but the urine still con-

tained a good deal of mucus and renal casts. The albumen had decreased to about one-eighth. There was no dropsy; nor indeed has there been throughout the case; but slight intermittent lumbar pain was common. The patient was put upon an entirely milk diet, with the exception of about 1 oz. of toast daily. During the greater part of November there was a total loss of appetite, which however was recovered in the following month. On December 25th, the patient having for two or three days complained of considerable pain in the region of the heart, a slight pericardial friction-sound was found to be audible on auscultation, though there was apparently very little effusion. Attacks of pain in connection with the heart were henceforth a marked feature of the case. The patient particularly complained of pain in the left arm and palm of the hand, more especially severe after palpitation, from which he not uncommonly suffered. These attacks recurred during a period of more than eighteen months from their first appearance.

Treatment
by milk.

Pericarditis
supervenes.

And, later
fibrillar
muscular
twitchings.

Towards the end of January the patient became affected with muscular twitchings. These supervened one night suddenly in the muscles of the left lumbar region, and were for some days so great as to interfere considerably with sleep. At first localised to the part mentioned, they afterwards became general, and gradually growing weaker in

character, they practically ceased in about three months, though even now the patient is subject to slight recurrences.

From this time his health gradually improved, and in June he was able to get out of doors for the first time. The albumen had decreased to about one-thirtieth, the urine was less turbid, generally neutral or slightly acid, but still contained the characteristic *Bilharzia detritus*. The slight hæmaturia still remained, but there was no difficulty in retaining the urine and no pain in passing it. The condition of the heart was better, the appetite good, and there was no lumbar pain.

Gradual improvement, but persistence of hæmaturia.

Throughout his illness, after the amelioration of the cystitis, no course of treatment by drugs was adopted. Till January the patient lived solely upon from four to five pints of milk and one ounce of toast daily, but after this date he gradually reverted to ordinary diet, alcohol alone excepted. He drank a considerable amount of soda-water and weak tea, finding himself always more free from pain and irritation with the urine largely diluted. A hot bath of a temperature from 104° to 107° was given every night.

In the beginning of October, 1879, the patient went to Madeira, and resided there eight or nine months with marked benefit to his general condition, though with but little change in the physical

signs of his disease. A chill caught from exposure to cold and wet in May, 1880, resulting in considerable lumbar pain, with scanty and offensive urine for some eight or ten days, seems to have retarded him but little, and he left the island living on ordinary diet, and able to take alcohol in moderation.

Present condition.

From that time his condition has undergone no apparent change. His present state is as follows: he is thin and somewhat anæmic, but on the whole is, for an invalid, in fair health and spirits. He weighs 9 st. 7 lb., which is some 10 or 12 lb. below his normal weight in health. He sleeps well, and has no loss of appetite, though he habitually eats but little meat. The digestive functions are unimpaired. Without being capable of great exertion, he can nevertheless walk some eight or ten miles without difficulty. His chief trouble is in connection with the bladder, slight irritation being not uncommon, especially after any prolongation of the interval between meals, or in the event of non-imbibition of free diluents. He suffers from hypogastric pain but rarely, when it is generally of a sharp but transient character. Pain in the right buttock is more common, and is almost always co-existent with bladder irritation; it is of a dull, rheumatic kind, and often lasts two or three days at a time, with occasional exacerbations. From

time to time the patient suffers from an acute lancinating pain in the perinæum and urethra, often so sudden and severe as to evoke an involuntary cry, but generally as fleeting as it is painful. The patient is firmly convinced that he can at times feel the actual movements of the helminth in the urethra, and, considering the size of the animal, it is not impossible. In addition to the foregoing symptoms in connection with the bladder, there is occasionally dull pain over the upper part of the sacrum.

A curious symptom with regard to the pelvic organs deserves a special mention. The patient is at all times extremely susceptible to cold, and from time to time, generally during the prevalence of cold weather, he suffers from a constant desire to defæcate. During these attacks he is in a state of utter misery. The dartos is tightly retracted, and there is generally a certain amount of vesical irritation; there are constant slight shivering fits, and, taught by experience that the rectum is really empty, and that it is useless to attempt to evacuate anything, the patient keeps constantly walking about in a state of extreme restlessness and discomfort.

The symptoms in connection with the kidney are but slight. There is now no lumbar pain sensible, except during flatulent distension of the intestines,

but it can always be induced by bending the body at the hips to a right angle with the legs.

The foregoing is, in brief, the history of this interesting case. I will now proceed to the consideration of the urine.

General
characters of
the urine.

The patient passes water almost invariably four times a day. The amount voided is generally from fifty to sixty ounces daily, sometimes slightly more; but that this is not an abnormal excess is evident when the fact of the increased amount of liquid usually drunk is considered. The morning urine is the most turbid, but it rarely contains much *Bilharzia detritus*, and equally rarely any blood-clots, unless indeed one or two small ones be expelled from the urethra by the first jet of urine. It is usually acid and somewhat dark in colour, and has a peculiarly strong sweetish odour. The urine, after lunch, is paler, but also very turbid; it contains a good deal of *detritus*, and is usually neutral or alkaline. That passed just before dinner, and on going to bed, is much clearer and paler, usually faintly acid, generally with two or three blood-clots often of very large size, and with a tolerable amount of *detritus*. At the three latter times of passing water, the characteristic hæmaturia is almost invariably present; about a tea-spoonful of mixed blood and urine being passed at the end of the act of micturition, which, it may be added, is now quite unaccompanied by pain.

If the urine be collected in a glass, and held towards the light, the appearances presented to the naked eye are such as, to the experienced observer, may fairly be called pathognomonic. Still floating in the urine—for they take some time to settle—are seen numerous colourless, shreddy filaments, of various lengths up to an inch or more; the smaller ones straight, the larger often branched and with the ends curled up, but all of them showing minute specks in their substance of an opaque white or yellow colour, but more rarely red. At the bottom of the glass is seen a heap of the characteristic *detritus*, which, for convenience of description, may be divided into three classes. (1) Minute opaque, roundish masses, not exceeding the size of a pin's head, either white, yellowish, or brilliant red. (2) Brightly blood-stained substances, almost exactly resembling small fragments of veins, often with two or three branches; of all sizes up to $\frac{3}{4}$ inch in length, with a breadth of from $\frac{1}{50}$ to $\frac{1}{10}$ inch, the external surface being formed of a thin white membrane, which can often be seen prolonged at the extremities; cylindrical in shape, but occasionally with slight fusiform dilatations. (3) Flat blood-clots, of which the patient has passed some as large as a shilling.

Characteristics of the
Bilharzia
detritus.

A microscopic examination reveals an abundance of objects, but of the crystalline inorganic deposits

Microscopic
appearances.

there are in the case under consideration happily but few. The ammoniaco-magnesian phosphates and the amorphous phosphate of lime are necessarily occasionally to be found, but uric acid crystals are somewhat rare, as also those of the oxalate of lime. There are, however, not unfrequently small rounded opaque masses to be seen, reddish or reddish-yellow in colour, showing no crystalline formation, but covered with minute tuberculations, and somewhat irregular in shape. These I take to be minute calculi, probably of uric acid.

Organic
deposit.

The organic deposit is very large, and is chiefly composed of pus and blood corpuscles and epithelial *débris*. The latter is abundant, and is composed of cells of nearly every size and shape, though the columnar and tailed forms are rare. Doubtless some are from the kidney, but the great preponderance of large-sized oval epithelial cells show the chief source to be extra-renal. Free amorphous pigmentary particles and cell-like bodies are common. The long whitish filaments, and blood-stained, vein-like substances just alluded to as so characteristic of this helminthiasis, are seen under a high power to consist of homogeneous fibres and mucus cells, forming a stroma in which are entangled and imbedded numerous ova, pus, blood, and epithelial cells, pigmentary particles, granules, and other *débris*. Besides the ova thus imbedded, many are

seen loose and unattached, while others are aggregated together in lumps of twenty or thirty. An occasional finely granular renal cast is seen, but they are by no means abundant.

So much for the general characteristics of the urinary deposit; I now turn to a more detailed consideration of the actual products of the helminth itself.

Seen in a clear medium, and unaffected by pressure or reagents, the ovum appears as a bright, translucent oval body with a very sharply-cut outline, blunt at one end, but provided at the other with a minute but acutely pointed spine. The length of the egg varies a good deal, some being considerably broader and shorter than others, but the average is between $\frac{1}{200}$ and $\frac{1}{160}$ inch. The spine is not more than from $\frac{1}{20}$ to $\frac{1}{17}$ of this length usually, but in some cases it is quite abortive, and in others, though rarely, entirely missing. Within the ovum the unhatched embryo is clearly to be discerned. The ovum.

The above characteristics are easily recognisable, even under a very low power: a closer examination fills in many details. The egg-case is a bright and perfectly transparent shell, unaffected by fairly strong solutions of acids, slightly yellowish in colour, without granules or markings, and showing a notable thickness best observable at the The egg-case.

broken edge after the escape of the contained embryo. In many instances that half of the ovum nearest the spine is slightly broader than the other: indeed it is rare to get examples of a true oval. The ovisac appears to be an extremely hard and indestructible body, and I have often noticed it to be apparently quite unaltered in putrid urine which has been left to stand for many days. The spine, as I have already mentioned, often varies considerably in length. It is usually placed parallel to the long axis of the ovum, but is frequently irregular, being in some instances slightly curved, and in others placed a little to one side of the actual pole. I have never seen any instances of a lateral or double spine. Cobbold regards this little process as 'a species of holdfast, the homologue of a variety of such appendages' in the ova of other species.

The contained embryo.

The perfect transparency of the ovisac permits the most minute examination of the embryo contained in it. In the great majority of instances this is seen to lie with its head towards the spine; this position being about three times as common as the reverse. Dr. Harley has figured ova in which they appear in both positions; but Cobbold says, probably from an error, that 'the tail is generally directed towards the spine-bearing end.' These unhatched embryos are in various stages of develop-

ment, from a mere aggregation of granules up to the complete animalcule just ready for extrusion. They are enclosed in a fine hyaline yelk-sac, which is generally not in contact with the shell at all points, but often has a tendency to leave the recesses of the two poles more or less unoccupied. These spaces, however, are usually more or less filled up with globules of a fatty nature, most abundant in the more mature ova, and generally apt to coalesce from the movements of the embryo at the moment of hatching. The embryo itself does not lie free within the ovum, but appears to be attached at two or three points—almost invariably at, or near, the shoulder on either side, and occasionally about midway between that point and the tail. Even from quite an early intra-oval period, the body is seen to be clothed with long cilia, the motion of which is distinctly visible in later stages, when slight motions of the body itself become evident from time to time, culminating at last in violent efforts just previous to the dehiscence of the ovum. So long as the embryo remains in the egg, but little trace of differentiation of structure is observable, though there is no difficulty whatever in distinguishing the head of the animal. The general mass of the body is composed of numerous highly refracting globules of various sizes, which towards the cephalic end are arranged so as to give rise to a somewhat

streaked appearance. In this situation, also, are seen two larger pear-shaped bodies, to which I shall have occasion presently to allude more in detail. It is to be understood, however, that these appearances only present themselves in the more matured ova.

In pure undiluted urine I have never been able to observe the mature free embryo in its active natatory state. Dehisced or half-dehisced ova are indeed not unfrequently to be seen, but I feel sure that in most cases this has been caused by pressure or other accidents. By artificial means I have succeeded in hatching some thousands of ova, but never in pure urine; and in the few cases in which the free embryo is to be seen in this liquid it is invariably dead or dying.

This absence of the embryo in a living state in the urine appears to be invariable, so far as I can discover, in cases of *Bilharzia* acquired in Southern or South-Eastern Africa; but it is a curious circumstance that Sonsino and others, whose field of observation lay in Egypt, have found the embryos invariably present. In the eight cases recorded by this Italian physician in his first paper on the subject, the embryos were present without exception. (The two last cases in this paper are incomplete, and may be disregarded, as there is no proof whatever that the patients were suffering from the

Bilharzia disorder.) What significance, however, if any, lies behind this clinical fact, I do not know.

The hatching of the embryo is one of the most wonderful microscopic sights with which I am acquainted. Instructive as is every instance of animal metamorphosis, few are more interesting than the case under consideration; none demonstrate more clearly the intense activity of some forms of animal life. The ova are readily hatched from the *detritus* at the bottom of the urine glass by pouring off the supernatant fluid and filling up the glass with pure water, so that the proportion of the latter to the urine is about twelve to one. The deposit being again allowed to settle, the ova may be removed for examination in five or ten minutes, and so quick in many instances is the process that I have often found embryos already extruded even in this short space of time. Water at a temperature of 76° to 80° Fahr. gives the readiest results, as might be expected from the fact that the pools and rivers in the countries where the Bilharzia is indigenous are seldom very much below that temperature. I have often, however, hatched ova in ice-cold spring water.

The hatching of the embryo.

If we now turn to a tolerably developed ovum under the microscope, it will be seen that the effect of the addition of the water has been to cause increased motion in the contained embryo. The cilia

are seen to be waving freely, and we can now notice that they invest the whole surface of the body, with the exception of the extreme anterior end. From time to time a strong heaving effort of the body itself is noticed; these movements becoming gradually more frequent. At the same time, the curious pig-like proboscis, which is now plainly visible, is poked from side to side as if in search of some aperture of exit, and the lower part of the body undergoes a series of contractions and extensions which serve to show distinctly that the globular cells, of which the animal appears composed, are unattached, and roll freely about in the interior of the body. The connections which fix the little animal to his shell soon become loosened, the shell suddenly bursts, and the process of hatching is, in these instances of quite ripe ova, soon and easily accomplished. But it is far otherwise in other cases. In the less-advanced ova the addition of the water seems to exert a rapidly ripening effect upon the embryo, which is in no way shared by the shell, and in these cases the phenomena observed are intensely interesting. The animalcule has soon become freed from his connections, but in spite of his exertions, the strong horny egg-case refuses to yield. The protruding proboscis is thrust in all directions, but without avail. Turning himself over and over, and round and

round in his shell, he vainly tries first one and then the other end, alternately contracting and extending the body to bring pressure to bear upon the shell-wall. Still without success, his efforts get more and more violent, till he finally works himself into a perfect fury of endeavour, during which, from their rapidity, it is often difficult to follow his movements. Such perseverance cannot long remain unrewarded. On a sudden the egg bursts, and he is freed from his prison. For a moment he pauses, as if astonished to find himself at liberty, and then, with a final struggle to free himself from the surrounding globules extruded at his escape, he darts rapidly off, and in an instant is lost to view.

Let us now turn to the dehisced ovum. The opening is seen to be almost invariably longitudinal; the rupture, however, as a rule, not being a perfect slit, but generally transverse also at the end opposite the spine—a portion of the shell being often observable turned back upon itself. Within are seen some of the fatty globules already referred to as being external to the body of the embryo, while others lie outside, having escaped at the moment of hatching. Besides these empty ova, a certain amount of abortive or, so to speak, addled ova are not unfrequently met with. They are generally completely filled with fine dark granules, and show no trace of structure whatever.

The de-
hisced
ovum.

The free
embryo.

The free embryo strikes one at once as admirably adapted for the medium in which it lives. Darting about with almost incredible rapidity, it is nearly impossible to follow its movements excepting under a low power, and its extreme restlessness is such as greatly to interfere with its useful examination in the living state. If, however, its movements be confined, the animal is seen to present the following characteristics: at the first moment of hatching it retains very nearly the form it presented while still within the ovum, but it very shortly begins to assume a more elongated shape. Tapering away towards each end, its broadest part is seen to be at the shoulder, at the junction of the first with the second fourth. The tail, or rather the posterior end, is rounded, while the cephalic end terminates sharply in the ceaselessly-moving oval proboscis. This is the shape as seen when the animal is swimming freely, but it is liable to great variation, especially if any obstacle be encountered. The power of contraction and elongation is very great; the body being sometimes made momentarily almost globular in form, while the snout is capable of protrusion and retraction to a considerable extent.

At an early period a certain amount of coalescence and arrangement of the somatic globules takes place, and soon in certain lights a distinct water

vascular system becomes evident, as has already been most accurately described by Dr. Cobbold: 'It consists of two main stems passing from head to tail, anastomosing, and having no excretory outlet visible at the tail.' I have not been fortunate enough to detect any distinct evidence of segmentation of the body. In the cases where I thought I had done so I have afterwards observed them to disappear. The pear-shaped sacs at the cephalic end, which I have already mentioned, are very distinct in the free embryo. From each of them a slightly tortuous canal leads forward to the oval sucker; but below, the sacs have apparently no outlet. They are doubtless the primitive forms of the digestive canal, which, in the adult helminth, is dichotomously divided just before the ventral sucker, to be again united lower down.

The motion of the cilia is so great, that if an embryo be fixed by pressure or other means, so strong a current is occasioned that pus and other small cells are drawn towards the animalcule from some distance in advance, and remain close to it, in a state of constant rotation.

I am disposed to think that the embryo has by no means so frail a tenure of life as some writers have supposed. Davaine, in his '*Traité des Entozoaires*, says: '*Dans l'eau ordinaire, il (l'embryon) perd au bout d'une heure son pouvoir de locomotion*' Vitality of the embryo.

tion, et se dissout bientôt ;' but he does not give his authority. It is, however, somewhat in accordance with Dr. Cobbold's observations, for the latter states that he was unable to keep embryos alive for twenty-four hours in any water in which he had introduced the smallest trace of mucus, blood-corpuscles, urinary crystals, or decomposing matter of any kind. This is certainly quite opposed to my own experience. In a mixture of one part of urine to eleven of water I hatched out an enormous number of ova, so that in a few hours the liquid could be seen swarming with the embryos. (I may here remark that, with a little care, they are easily visible to the naked eye.) On the second and third day they appeared undiminished in numbers, and looked perfectly healthy under the microscope ; but on the fourth day there were decidedly fewer, and many dead and torpid ones were found. On the fifth day not one was to be seen, but some not yet quite dead were found at the bottom of the glass. Water being undoubtedly their natural element, it is difficult to see why they should perish in it. Acids, however, even if diluted, colouring matters, tobacco-water, etc., soon kill the embryo, which in many cases bursts in dying, the somatic globules exuding at all points. If the animal be killed by pressure, the cilia move for some time after it is apparently dead ; but if slight pressure merely be

employed, exudation of a few globules only may take place. In the latter case the embryo may live for some time, but its power of rapid and straight locomotion is gone; it spins round and round as if in pain, or else progresses in a series of loops. If treated with strong acids, death is almost instantaneous; the animal becomes immediately motionless, the cilia surrounding the neck stop, then those of the rest of the body, and within five seconds life is extinct.

The foregoing observations upon the microscopic characters of the ovum and embryo embody roughly the result of many hundreds of examinations. The serious character of the disease and the limited knowledge we have of the life-history of the animal will, I trust, be an excuse for my having dwelt upon them somewhat at length. Before leaving my type case for a general consideration of the disease, I must add that the patient's urine does not contain sugar, and that there is little more albumen present than can be accounted for by the bladder symptoms.

CHAPTER II.

DISCOVERY.—LIFE HISTORY.—MODE OF INFECTION.—
GEOGRAPHICAL RANGE.

Discovery
of the
Bilharzia.

IN a 'Contribution to Helminthographia Humana, from epistolary communications from Dr. Bilharz in Cairo' (published in *Zeitschrift für Wissenschaftliche Zoologie* for 1853), we have, as far as I know, the first allusion to the disease. Dr. Bilharz writes, under date May 1st, 1851:

'As far as regards the helminths in general, and also those infecting man, I believe Egypt to be one of the most favourable countries for their development, and for the study of them. The nematodes especially inhabit the intestinal canals of the natives in often incredible numbers, and it is no uncommon thing to find in a single body 100 specimens of *Strongylus duodenalis*, 20-30 of *Ascaris lumbricoides*, 10-20 of *Tricocephalus dispar*, and some thousands of *Oxyuris vermicularis*. In Abyssinia the tapeworm is so common that a native looks upon it as an abnormal state of things if he has

never passed a portion of one ; and no slave would be sold there who did not carry with him some kousso.'

After describing other parasites, he goes on to say :

'After my attention was directed to the liver and its attachments, I soon found in the blood of the portal vein a long white helminth in abundance, which with the naked eye I took for a nematode, but soon recognised as something new. A glance with the microscope enabled me to distinguish a splendid distomum.'

He then partially describes it ; finds no sexual organs ; notices the gynæcophoric canal, but cannot explain it. In August, 1851, he again writes :

'I have not yet told you the new phase into which my portal-vein worm has passed. Instead of developing, as I half expected, into a fine cock-and-bull story (*ammengeschichte*), I may almost say that it has come to something more wonderful still—a trematode with distinct sexes.'

On the discovery of Bilharz, Griesinger and Leuckart have grafted many pathological facts, though they have given but few clinical details. Hitherto, indeed, our knowledge of this part of the subject has been somewhat limited, though Dr. Harley's account of his South African cases has added much to it.

Still more meagre, at the present moment, is our Its life-history.

knowledge of the life-history of this helminth. I have never seen or known personally of a fatal case from the effects of its ravages, and am therefore unacquainted with the adult worm. Bilharz's description of it, however, is as follows :

The adult
helminth.
Male.

‘*Distomum hæmatobium*, sexu distincto. Maris corpus molle, albidum, filiforme ; parte anteriore totius longitudinis octava vel nona, (trunco) depressa, lanceolata, subtus plana vel concava, supra leviter convexa, superficie levi ; reliqua corporis parte terete ; margine corporis ab acetabulo ventrali retro utrinque versus faciem ventralem con-flexo, eoque modo canalem gynæcophorum efficiente ; apice postico attenuato, superficie externa tuberculis piligeris conferta ; superficie canalis interiore linea mediana levi, et partibus lateralibus aculeis minutissimis scabra. Acetabulum oris apicale sub-inferum, triangulare. Acetabulum ventrale sub finem trunci insertum, orbiculare, eadem magnitudine cum acetabulo oris. Superficies utriusque acetabuli granulis minutissimis scabra. Canalis cibarius sine pharynge musculari, ante acetabulum ventrale in duas partes divisus, et in posteriore caudæ parte denuo unitus, cæcus. Porus genitalis inter acetabulum ventrale et canalus “gynæcophori” originem situs.

Female.

‘Femina forma dissimilis ; tenerrima, gracillima. Corpus “tæniæforme,” leve, hyalinum ; antice

sensim valde attenuatum. Cauda canali nullo apice angustata. Acetabula et canalis cibarius ut in mare. Porus genitalis cum margine posteriore acetabuli ventralis coalitus.

‘Longitudo tres ad quatuor lineæ, mas feminam latitudine multo superans.’

Bilharz remarks that the pointed end of the ovum is always directed backwards as it lies in the uterus or ovarian canal. Sonsino also remarks the same thing with regard to the *Bilharzia bovis*.

Dr. Cobbold further states that the female worm is about four-fifths of an inch long; that the intestinal canals reunite to form a broad, central, spirally-twisted tube, extending down the middle of the body; and that the vitelligene and germigene canals combine to form a simple oviducal canal, which is continued into a simple uterine tube, finally opening near the lower margin of the ventral sucker.

The *Bilharzia* has been found in various situations in the human body. Griesinger and Bilharz discovered it in abundance in the portal and mesenteric veins, where it seemed to occasion but little trouble. It is chiefly in connection with the urinary system that its effects are most patent, and cases come under consideration almost invariably from the existence of the hæmatozoon in the veins of the bladder and urethra, and the hæmaturia

Situation in
the human
body.

caused thereby. It exists also in the ureters and pelvis of the kidney, in the spleen, in the hepatic vein according to Davaine, and also, commonly, in the lower bowel. With our limited acquaintance with the worm, and its proved occurrence in such various parts, it is fair to conclude that its existence is possible in almost any part of the abdominal cavity. According to Davaine, 'In the mesenteric veins the males have the female enclosed in the gynæcophoric canal, but in the veins of the walls of the intestine, of the liver, and of the spleen, they are always separate.'

Probable
inter-
mediate
stages.

Having now considered the animal both in the earliest stages of its existence and in its adult condition, the question naturally arises as to whether it passes through any other stage or stages intermediate between these two periods—a question very intimately bound up with that of its mode of introduction into the human body. That it does do so, and that it requires some host other than the human individual for its development, is, I think, more than probable from the following considerations :

Metamor-
phoses of
the *Fasciola*
hepatica.

The life-histories of but few of the trematode worms are thoroughly known, with the exception of that of the common liver-fluke (*Fasciola hepatica*), which causes the death of hundreds of sheep annually in England. The various metamorphoses of

this distoma are as follows: The free ova escape in numbers from the alimentary canal of the infected animal. By various agencies many of these ova find their way to ponds, ditches, and other water. Here they are hatched into a free-swimming, ciliated embryo. After a time the cilia fall off, and the animal invades the body of some intermediate host, generally, according to Willemoes-Suhn, the gasteropod *Planorbis marginata*. Here they develop into a sporocyst (*redia*) capable of generating larvæ (armed *cercariæ*), which in their turn pass into the bodies of sheep and other animals, to become the mature fluke. Arguing from analogy, therefore, it is exceedingly likely that the Bilharzia, belonging, as it does, to the same genus (distoma), and with its embryo closely resembling that of the *Fasciola hepatica* (Cobbold, 'Parasites,' p. 48), goes through a somewhat similar form of life-history. This probability is strengthened by the fact that Dr. Harley was unable to infect dogs and rabbits after prolonged feeding upon the eggs and larvæ.

Again, as possibly tending negatively to support the probability of an intermediate stage, it may be mentioned that as yet no case of communication of the helminth from husband to wife has ever been recorded.

Dr. Cobbold's inability to breed the Bilharzia

in many molluscs and fish may be mentioned, though the deductions drawn from it must of course be of a purely negative character.

Mode of
infection.

What, then, is the method of introduction into the human body? I think Dr. Harley's suggestion that the so-called 'Natal Sores' are caused 'by the minute leech-like animal fixing itself to the skin of the bather, and by means of an ovipositor implanting the ova in some superficial vein, resulting in an indolent form of ulceration,' may at once be dismissed. In the first place, it is unlikely that the adult distoma exists in a free state in the water; secondly, it is not provided with an ovipositor; and lastly, the origin of these 'Natal Sores' is well known in that country. They are caused solely by the bite and subcutaneous burrowing of a small species of tick (*Ixodes sp.?*) not larger than the point of a pin, and I myself am personally well acquainted with this minute arachnid and its ravages. Dr. Rubidge, of Algoa Bay, thinks that 'the parasite gains entrance to the skin while bathing;' and says, in support of this, 'I never met with a case in boys who did not frequently bathe in the Zwaartkops (the river at Port Elizabeth); and those few boys in the families of my patients who are free from the disease, bathe in the sea only.' He does not suggest the means of introduction, but if the human host be invaded

through the skin, it is most probable, assuming a like series of metamorphoses with the *Fasciola hepatica*, that the invader is in the cercaria stage.

Another suggestion that has been made, and certainly a curious one, is that of the direct passage of the animal, immature or otherwise, into the urethra or anus. Whether it may have any connection with the subject or not, I cannot say, but I have been told by a gentleman that, in some parts of Cambodia or Siam, the natives are in the habit of tying up the prepuce before crossing certain rivers, stating that if this precaution be not taken, they run the risk of becoming attacked by an animal which passes up the urethra and eventually causes death.

The third and final theory is that the animal finds its way into the body through the mouth, either by means of vegetable or other food, or by drinking water. Against this has been adduced the undeniable fact that, at any rate in South Africa, the animal is chiefly, if not entirely, confined to the urethra and bladder. 'Why,' it is asked, 'should the animal be so localised if it has been introduced into the system through the stomach? Is it not more reasonable to suppose that it has reached its destination by a more direct route?' The obvious answer is, that the induction is valueless, from the fact that almost every parasite, whether

external or internal, has its favourite organ or part. Dr. Harley thinks (Med. Chir. Trans.) that the size of the ovum and embryo do away with the idea of a general infection of the system by means of the absorbents. The egg is certainly so large as apparently to be unable to pass through the smaller bloodvessels, but the embryo is much smaller, and capable of considerable elongation; and circumstances have lately come to light which lead to the supposition that larger bodies are capable of passing through the capillaries than is generally supposed. Griesinger, too, has found the ova of the *Bilharzia* in the left heart. It is difficult to see where these could have come from except through the pulmonary capillaries, for it is impossible to suppose that such a close observer should fail to notice the presence of the adult helminth in the heart or pulmonary veins.

The male sex much more commonly affected than the female.

It is an undeniable fact that the *Bilharzia* is found to affect the male very much more commonly than the female sex. Griesinger does not mention the proportion with respect to sex in his 117 autopsies; but all Sonsino's cases were, without exception, males. Dr. Harley had one female patient, but personally I have never seen or known of an instance other than in the male sex. Sonsino suggests that in his case the apparent absence of the disorder among females may be accounted for

‘dalla maggiore avversione con cui il sesso femminile dà conto delle malattie che hanno rapporto con certi organi, e anche da ch  nelle donne il mitto cruento pu  essere confuso col sangue di provenienza dall’ apparato genitale.’ The first of these explanations would certainly not hold good in a more civilized community, while the latter is exceeding unlikely anywhere, bearing in mind the irritation and constitutional disturbance that is generally set up at the onset of the disorder.

To what, then, is this immensely greater liability of the male sex due? The suggestion that the explanation lies in the difference of sexual formation naturally offers itself, but is, I think, untenable. For, if the mode of infection be by the mouth or through the skin, there is certainly no anatomical reason why the disorder should not affect both sexes equally, while, if it be by the direct passage of the animal into the urethra, the vulnerability of the female would be probably greater. The explanation, therefore, probably lies in the different habits of life of the two sexes, and in no way do they differ more than in the frequency and manner in which they bathe. River-bathing is but seldom indulged in by women, but in the tropical or sub-tropical countries in which the Bilharzia is prevalent, the European or Colonial male youth often spend no inconsiderable portion of their day in

the water, and I cannot help regarding this habit as being in some way or other connected with the acquiring of the disease. If it be so, we must reject the theory of infection by the ingestion of the animal in an immature state in the bodies of fish or minute molluscs, and fall back on that of the direct passage of the parasite, probably in the *cercaria* stage, into the skin or natural apertures of the body.

Geographical range
of the
Bilharzia.

Arabia.

Egypt.

West Africa.

Cape Colony.

The exact geographical range of the Bilharzia is most difficult to define. I think, however, that I am right in saying that the actual proof of the existence of this animal in cases of hæmaturia has as yet only been evidenced in patients from the African Continent and from Arabia; but that there is a strong probability of its existence in other countries I hope presently to show. In Africa it is chiefly abundant in Egypt and in various localities in the southern part of the continent. My own knowledge of the West Coast is not sufficient for me to speak with certainty, but from information I received from a medical gentleman who had resided for some time in several of the colonies on that coast, I am inclined to believe in its existence there. South Africa requires a more detailed consideration. I am unaware of any cases having been recorded as originating in the western provinces, but along the south-eastern seaboard it is a tolerably

common malady. Almost all, if not all, of the recorded cases have occurred eastward of the great watershed running from the Lobombos to the Sneuwbergen—a curious circumstance when we consider the vast amount of country drained by the Orange. In the case quoted at the beginning of this paper, it is quite possible, if not probable, that the disease was acquired in the interior; but it ought to be mentioned that, about a year previous to the onset of the symptoms, the patient had been residing at Algoa Bay, and in other parts where the helminthiasis is known to be endemic. Uitenhage is especially affected, while other known localities for the disorder are Fort Beaufort, Alice, Grahamstown, and some parts of British Kafraria (Dr. Spranger). Owing to the extremely sparse white population in Free Kafraria, we have no information regarding its existence there; but a little to the north—in Natal—it is again to be noted as a frequently occurring disorder. With regard to this colony and Zululand, Dr. Lyle says the affected area extends from the Umkomanzi to the Umvaloosi; but as he is guilty of the considerable geographical error of supposing this latter river to flow into Delagoa Bay, this statement cannot be regarded as absolutely reliable. At Pietermaritzburg, according to Dr. Batho ('Army Med. Rep.,' vol. xii.), 'it seems as if the majority of the male

Kafraria.

Natal and
Zululand.

youth suffer from it ;' but I have no hesitation in saying that this is an exaggeration, though I am personally well aware of its tolerable frequency in that town. I have never met with a case in the interior, nor did I find that any of the old Zambesi hunters whom I questioned were acquainted with the disease, though they are generally keen observers.

The ætiology of the disease under consideration is so closely connected with that of the so-called 'chylous urine,' and the two have so many symptoms in common, that a moment's consideration of the latter is necessary before passing to other countries. Davaine, indeed, classes simple hæmaturia and *hématurie graisseuse* together, under the head of endemic hæmaturia, and goes on to tell us how this latter malady may make its appearance at first by the simple presence of blood in the urine. It may last thus some time; then uric acid deposit may become evident, and the urine eventually turn chylous, so that the patient who was hæmaturic in infancy may pass chylous urine in adult life. This is usually the course of events in Mauritius, where, according to Davaine, about one quarter of the population are more or less affected. But it is far otherwise in Brazil; the patients in that country are almost invariably attacked in adult life, as appears also to be the case in the West Indies and

India, and the explanation seems undoubtedly to be that, though the disease is everywhere caused by the presence of hæmatozoa, in the African countries it is due to a distoma, either alone or co-existent with the filaria, and elsewhere to the *Filaria Bancrofti* alone.

The descriptions given by Salesse, Chapotin, and Todd of the hæmaturia of the Ile de Bourbon and Mauritius can leave no doubt of the disease being due to the Bilharzia, and, as still further bearing on the subject, may be adduced the following passage from Davaine : Mauritius
and
Réunion.

‘D’après les faits que j’ai compulsés, cette complication (la gravelle) si fréquente en Egypte et à l’Ile de France, ne se montrerait pas dans l’hématurie graisseuse du Brésil, ou de l’Inde. Si le fait est exact’ (which appears to be the case) ‘nous trouverons ici une preuve de plus en faveur de la nature parasitaire de cette maladie, car, dans les contrées Africaines, les œufs de la Bilharzia forment les noyaux des calculs, tandis qu’au Brésil et dans l’Inde ce sont des larves qui se rencontrent dans les urines et non des œufs. Il n’y a donc point dans ce dernier cas une condition déterminante des concrétions urinaires, et les différences qu’on observe dans la maladie en Afrique et au Brésil tiendraient à la différence des entozoaires qui la causent.’

The existence of the Bilharzia in other countries is at present merely conjectural, but, reasoning on geographical grounds, it is extremely probable that the hæmaturia known to be endemic in some parts of Madagascar. of Madagascar owns the same cause as that prevalent in South-eastern Africa on the one hand, and in Mauritius and Bourbon on the other.

CHAPTER III.

SYMPTOMS.— DIAGNOSIS. — PATHOLOGY.— PROGNOSIS.—
TREATMENT.

THE period of incubation of the disease under con- Period of incubation.
sideration appears in some cases to be very pro-
tracted. Thus a patient of Dr. Harley's left Natal
for Japan, in which country he stayed a week or
two; and it was not until he was on his homeward
voyage that he first noticed any symptoms of the
disorder. A still more curious instance occurred in
a case of my own. The patient, E. H., who was in
the same expedition with A. B., returned with the
latter to England in August, 1878, and in the
autumn went out to Minnesota. It was not until
the spring of 1879—nine months after he had left
Africa, and more than a year after his friend first
showed evidence of the disease—that he himself
became affected. Dr. Lyle, however, says that
many of the plantation coolies in Natal became
Bilharzie within six months after their arrival in
that colony, while in the case quoted by Dr. Roberts

the patient's hæmaturia commenced within four months of his arrival at Cairo.

Symptoms.

The symptoms of the disease are in general tolerably constant, the patient in South Africa, at least, almost always coming under treatment for affection of the bladder or urethra. The mode of onset of the symptoms may, however, be somewhat variable. Sometimes hæmaturia seems to be the symptom first noticed, but in most cases bladder irritation and pain precede, with sharp burning pain in micturition if the neck of the bladder and urethra be affected, which seems generally to be the case. In some instances, however, there is but little pain. About a month or so after the onset of the symptoms there may be a remission of the vesical or urethral pain, owing to the parts having become, as it were, tolerant of the invader. If the urethra be considerably affected the pain during micturition is intense; priapism is not uncommon, and in a case I saw the patient suffered greatly from irritation of the generative organs, there being sometimes as many as four or five seminal emissions during the night. At first the urine may contain but little deposit, minute blood-red specks alone being visible, but as the disease advances the *Bilharzia detritus* becomes more abundant, the characteristic vein-like substances become larger, and the increased number of pus-cells show that

the animal has set up a certain amount of inflammation around its points of localization. The description already given of the appearance of the urine renders a further allusion to this subject unnecessary, but it may be mentioned that a general cystitis seems rarely, if ever, set up.

The hæmaturia, as might be expected from the fact of the source of the bleeding being from the urethra and bladder, is almost always at the end of micturition, when about a teaspoonful of bloody urine is voided, rarely, if ever, pure blood, though blood-clots, large enough to obstruct the flow of urine, are sometimes passed. In some cases the hæmaturia is intermittent, even for days or months at a time, and in every instance it is more or less increased by exercise. After having lasted some years it may disappear. This seems often to occur about the age of puberty in cases where the patients have become affected in infancy, but that the disease is cured simultaneously with the cessation of the hæmaturia is, I imagine, not so often the case as is generally supposed. Dr. Harley considers that this apparent amelioration is probably due to the distoma becoming encysted.

Several observers have noticed the fact that the shirts of Bilharzia patients are often stained with blood, but I am not aware that any reason has been given for it. After the act of micturition is quite

completed, a small amount of mixed blood and urine remains in the urethra, and escapes a few moments later. This I take to be the result of deficient power in the accelerator urinæ muscle, and the patient mentioned in the beginning of this paper was in the habit of obviating the difficulty by pressing the hand forwards along the course of the urethra at the end of micturition.

Hypogastric pain is not uncommon, though it is generally not severe or lasting. In one case, however, that I am acquainted with, the patient, a youth of nineteen, at school, was unable to play football or cricket, and could walk but little, and that in a stooping position, owing to paroxysmal pain in this region, which was always increased by exertion. At the end of eight months, however, he was apparently well again. In addition to this symptom, pain in the lower part of the back, in the buttock, and in the inguinal region, may be mentioned as not unusual.

Anæmia is generally present to a greater or less degree, and the patient feels weak and irritable, and disinclined for exertion. In some cases freedom from pain and discomfort is so rare that the patient may be said never to know what it is to feel well.

Later on in the disorder, especially if the kidneys be affected, symptoms of calculus may appear, with

attacks of renal colic from time to time. This is doubtless one of the gravest effects of the disorder, and one for which the physician should be ever on the watch.

The occurrence of liver abscess, septicæmia, paralysis, etc.—the result of the passing of pus, or the actual products of the animal, into the circulation—are apparently so rare as to need no further allusion.

The effect of age upon the liability to the disease needs a moment's consideration. That young children from three years old and upwards are specially affected there is no doubt, but Surgeon-Major Batho is in error when he says that 'it never attacks persons of middle or old age.' Dr. Ensor, of Port Elizabeth, informed me of a case in which the disease was acquired when the patient was nearly fifty; and Dr. Spranger had a fatal case at the age of seventy-six. The disorder is indeed tolerably common in young middle life.

Age in relation to the disease.

With regard to the diagnosis of the disease, there ought to be but little difficulty if only ordinary care be observed. A microscopic examination of the urine in a suspected case at once places it beyond all doubt; but, to a person well acquainted with the disease, the naked-eye appearances presented by that fluid are amply sufficient for a recognition of its cause. The gentleman who is the

Diagnosis

subject of the type-case in this paper was told that he was suffering from a subacute cystitis, secondary to his attack of dysentery, but in his case the hæmaturia did not appear till later. In the event of a microscope not being accessible—a not improbable contingency in the countries in which the disorder is prevalent—the disease with which it might most excusably be confounded is vesical calculus. The pain and irritation, the tenesmus, and, finally, the expulsion of the few drops of blood at the end of the act of micturition, are symptoms alike of both disorders. Leuckart also says that on catheterizing the patient, rough surfaces may sometimes be met with which might be mistaken for calculi. They are, however, not difficult to recognise on account of their immobility and woolly feel. The diagnosis in these cases would chiefly rest upon the tangible evidence of the calculus by the sound. In the disorder under consideration the pain is not increased by jolting or other movement, there is no pain in the glans penis, and no feeling of a foreign body within the bladder. New growths, such as cancer, might possibly be erroneously diagnosed; but, in addition to the ordinary microscopic examination, doubt is further set at rest by the absence of cachexia, and, generally speaking, by the comparative youth of the Bilharzia patient.

On the pathology of this helminthiasis, I am Pathology. unable to speak personally. There is, as far as I am aware, no published record of any South African autopsy in which this worm has been found. In hot countries post-mortem examinations are rarer than in our own temperate island, or some observations of its occurrence would ere this doubtless have been recorded. It is to German helminthologists that we are chiefly indebted for an account of the appearances presented after death, and Leuckart's admirable description has well-nigh exhausted the subject.

The following passage contains nearly everything that is worthy of note :

‘When thus wandering, it (the *Bilharzia*) will soon pass into vessels which it completely fills, and may perhaps dilate before it can enter. It follows naturally that the flow of blood in the vessels is stopped, and that, further, the ever-increasing number of eggs will act upon the walls of the vessel as an irritant. In consequence of this irritation, there will arise at the point of attachment of the parasite a more or less circumscribed inflammation, which may have a result according to the position and relations of its seat.

‘By far the commonest and most important of the phenomena thus caused are the changes in the urinary tract, especially in the bladder and ureters.

These changes begin usually with a catarrhal inflammation, which is, however, seldom seen alone. The mucous membrane of the affected spot is deeply reddened, and often surrounded with varicose capillaries; and upon the swollen surface is a layer of glossy mucus, which, made as it is of epithelial cells, may for the most part be lifted up like a thin skin, and covers many small bleeding points. The mucus, the extravasated blood, the congested mucous membrane, and even the more deeply placed connective tissue behind it, contain in such cases numberless masses of distomum eggs, which in some cases appear to lie singly, and in others to be lumped together by a connecting membrane. These eggs generally exhibit all possible stages of development up to the ripened embryo, and one may often even recognise numerous empty or burst egg-shells, which show that a portion of the embryos at any rate have already left their original dwelling-place. In most cases this inflammation goes on to absorption of the fluid exudation, with drying up of the vessel to induration. One finds occasionally in the place of the previous affection a discoloured, often yellow or green, pigmented bloodless thickening, of leathery consistence, as if it had lain for some time in spirit. On nearer observation this has an appearance of finely granular sandstone. Numerous little imbedded and shining granules

are to be seen, which cause the knife to give a grating sound on section. Under the microscope one recognises these as distomum ova, which have, however, no longer any living contents, but are mostly filled with carbonate of lime.

‘The surface of these patches of mucous membrane often bears a rough layer, the thickness of linen, which is pretty firmly adherent, and consists of degenerated epithelial cells: this corresponds to the skin already described over the acutely inflamed mucous membrane. These layers contain the same ova as are found in the deeper hardened layer, but in addition there are often numerous larger or smaller concretions which may have grown to the size of millet seeds, and appear mostly to consist of uric acid. These are sometimes only loosely bound to the rough layer, but sometimes closely held in by it, and appear from the character of their nuclei to be formed by incrustation on the distomum eggs. Between and about these concretions small microscopic molecules are often situated, which by their appearance seem to be composed of urate of ammonia.

‘The above-described appearances may be present on any or every part of the bladder, and may even cover more than half of its whole surface.

‘In the ureters they usually form ring-like deposits, which often so narrow the lumen of the

duct that the finest sound can hardly be passed through. The natural consequence of such a constriction is a dilatation of the upper part of the ureter, and then of the pelvis and calices of the kidney. In a case of complete obliteration which Bilharz observed, the kidney substance had entirely disappeared, and the organ was converted into a cyst filled with serous fluid.

‘As a rule these changes occur in the ureter at several spots, but most commonly low down, where it opens into the bladder, so that the consequent dilatation is then spread out over the whole canal.

‘In other cases the changes have a very puzzling appearance. One may find on the mucous membrane of the bladder single, or sometimes grouped, excrescences, not unlike condylomata, with or without pedicles, which may present manifold varieties in shape, and may be as large as a bean. They are softish, and of a yellowish or claret colour, derived from the numerous bloodvessels which course in them. Their rounded, easily-bleeding surfaces are often covered with an incrustation which partly consists of the ova of the parasite, and partly of urinary salts. On section, the mucous membrane seems thickened, and the submucous connective tissue hypertrophied. Both are pervaded by a rich network of capillaries, the vessels being sometimes much dilated, and here and there

changed to rather large cavities, which often contain full-grown specimens of the distoma. In the parenchyma of the excrescences, which is formed chiefly of submucous tissue, numerous eggs are found, for the most part in a new state.

‘This form appears contradictory and puzzling, but there exist between it and that first described numberless intermediate stages, often in the same bladder, which can be taken as evidence that both are only different phases of the same disease. Perhaps the difference may arise by this means—that in the one case it is the ova, and in the other the living animals, which act as an irritant on the mucous membrane and submucous tissue.

‘The muscular coats of the diseased urinary tracts, though rarely changed even by a high degree of the disorder, are easily hypertrophied. Only once has the remarkable condition been found that even the serous membrane on the bladder, and the adjoining layer of peritonæum, showed very darkly pigmented excrescences of cockscomb form.

‘Under certain circumstances the primary inflammation may lead to ulceration instead of induration or polypoid hypertrophy. This at least occurred in a case observed by Bilharz, in which the posterior wall of the bladder at one spot, the size of a half-crown, was indurated and leathery, and at another was acutely inflamed. In the latter part, an ulcer

the size of a fourpenny-piece was found in its floor, ragged and sloughy, and surrounded by swollen and dark reddened edges, reminding one of the ulceration of the lower bowel in dysentery. The floor contained egg-shells.'

The pathology of the curious vein-like or thread-like substances so constantly found in the urine, and so characteristic of the disease, is not so easily explained. Dr. Harley considers that 'the mucus in which the ova are imbedded is derived from the crypts in which the animal takes up its abode; the growth of mucus corpuscles being due to the irritation of the parasite and its eggs. As the mucus fills the crypt, it is forced out by the continual production of the ova, and being thus roughly moulded, appears in the urine in the form of little pellets or strings.'

Davaine's account of the post-mortem appearances is apparently chiefly borrowed from Leuckart's and Griesinger's works, but he describes the kidneys as being generally bulky and gorged with blood, with the mucous membrane of the pelvis and calices injected. The organs undergo fatty degeneration; or pyelitis and dilatation of the pelvis and calices, with atrophy of the renal substance, is observed.

Griesinger's finding evidence of the disease in one half of his autopsies in the summer, and in only one quarter in the winter, cannot be regarded

as anything more than a coincidence, though he suggests it as rather dependent upon the different vegetables in season ('Beobachtungen über die Krankheiten von Egypten').

On the question of the gravity of the disease, Prognosis. there is a considerable difference of opinion. Surgeon-Major Batho's statement, 'that it must be regarded rather as one of the curiosities of pathology than as an affection of much gravity or importance,' is widely at variance with Leuckart's view that it is the most terrible form of helminthiasis existent. Probably the mean of these two statements is nearest the truth, but until we learn more of the clinical history of the disease any knowledge of the probable issue of a particular case must necessarily be somewhat conjectural. That Possible occurrence of calculous disorders. the disease frequently leads directly or indirectly to the formation of stone in the bladder, there cannot be the faintest doubt. On this subject Leuckart says: 'The assumption of a genetic connection between this (Egyptian) lithiasis and the distoma disease is supported by the well-known fact that the presence of mucus and blood-clot in the urinary passages is one of the commonest causes of stone formation. The connection is also satisfactorily to be made out in other ways. That the surface of the degenerated spots of mucous membrane are almost always covered with urinary concretions,

we will not bring into consideration ; nor will we lay stress on the presence of the calcareous eggs in these degenerations, though it might be said that all these might possibly become developed into large stones. Where direct observations can speak for themselves, however, no objections can be made, and it is by direct observation that Rayer has proved beyond doubt the co-existence of the Egyptian lithiasis with the distoma disease. In all cases where the urine of Egyptian calculus patients could be examined, it was found to contain a great quantity of the eggs. Bearing out these observations is the fact that the nucleus of an Egyptian calculus was found to enclose a number of eggs ; while the whole, by its form and the relations of its several layers, proved to be a pedunculated hypertrophic polypus, upon which layer upon layer of calcareous material had been deposited.

‘It need hardly be said that the secondary diseases which may occur in consequence of the Bilharzia are not without the most damaging effect upon the general system. In a whole series of cases, Griesinger saw this disease sooner or later ended by general decay and death. Most of these individuals died after complete shattering of their constitutions from diarrhœa, pneumonia, and other acute diseases. Whether these may possibly in some other way bear relation to the parasitic

Or death
from
gradual
breaking
down of
constitu-
tion.

disorder, our knowledge can at present hardly determine. The possibility of such a relation is, however, all the more difficult to deny, since Griesinger has found no apparent pathological changes, excepting copious fresh processes of the *Bilharzia*, in individuals who have died from rapid nominal typhoid.'

With regard to the relation between this disease and diarrhœa, Leuckart goes on to say: 'In many cases changes take place in the large intestine in diarrhœa which not only resemble the distoma processes in the bladder—especially the fungous hypertrophies—but also show the *débris* of the eggs. Even where the changes in the large intestine have a different appearance, these deposits of ova are so common that Bilharz for a long time held that the endemic acute and chronic diarrhœa of Egypt bore the same relation to the parasitic disease "as scratching does to scabies."'

Personally I have never met with any fatal case, as I have already stated; nor has Dr. Lyle, whose acquaintance with the disease in Natal was considerable. It is, however, more than probable that many deaths, of which the *Bilharzia* has been the actual starting-point, are attributed to the subsequent secondary disease only. Besides the tendency to the formation of calculus, of which the cases already alluded to are an abundant evidence,

the train of diseases arising from chronic local cystitis or occlusion of the ureters must always be regarded as of possible occurrence. The constant presence of uric acid or oxalate of lime crystals in the urine, with a co-existence of prolonged anæmia and a tendency to diarrhœa, would certainly lead one to consider the case of a grave nature, as would also the distinct evidence of much renal affection. One would certainly imagine that the invasion of the urethra would in many cases eventually lead to stricture, but I am not aware of any instance of its having done so. With regard to the theory advanced by Griesinger, just quoted, that the disease may occasionally run an extremely rapid course of a typhoid nature, I would submit that it is much more probable that the Bilharzia was only a contemporaneous accident, since he himself testifies to having found the animal in 117 out of 363 autopsies.

Recovery is certainly possible, though I cannot help thinking that in the majority of instances of infection at adult life the patient never again recovers his health, though he may survive for years. The occurrence of the disease in healthy young children may, however, doubtless be regarded in a far more hopeful light.

Prognosis
better in
children.

Treatment.

In the treatment of this disease, the indication would naturally appear to be, (1) to ensure the

death and expulsion of the parasite, and (2) to obviate the various symptoms as they arise. But, unfortunately, with regard to the former object, it must be stated that all endeavours have hitherto proved unsuccessful. In the case of worms lying freely within the intestines, the action of various anthelmintics can be depended on with certainty ; but with a hæmatozoon it is different, and it is difficult to imagine a drug which should prove fatal to so hardy an organism without injuring its host at the same time. Turpentine, copaiba, cubebs, santonine, and buchu have all been vainly tried, as has also the extract of male fern. The latter preparation, combined with the oleum terebinthinæ, has been recommended by Dr. Harley as efficacious in assisting the discharge of the ova ; but it is evident that the turpentine should be used with great caution if the kidneys be affected. The foregoing remedies, as well as juniper and the iodide of potassium, having failed in causing the death of the parasite, Dr. Harley proceeded in 1869 to try the effect of medicated injections into the bladder. Infusions of wormwood and of quassia gave no result, but with the male fern considerable irritation and strong expulsive efforts of the bladder were caused, which brought away many products of the parasite, but failed to kill it. The iodide of potassium was next tried, with increasingly strong

Anthel-
mintics
useless.

Topical
medication
injurious.

solutions up to thirty grains in five ounces of water.

These injections were usually retained three hours, the salt was readily absorbed, and catarrhal symptoms resulted, but never any vesical irritation. For this treatment Dr. Harley claims the following advantages: 'That it was effectual in clearing away the products of the parasite; in securing their expulsion as fast as they were formed; and, ultimately, in destroying the adult parasite.' As, however, he admits that the patient upon whom this course was tried was still passing ova on and after his return to Natal, even after a continuous treatment of some months, I fail to see that he has established his proposition. Bearing in mind the disastrous train of symptoms which followed in the type case at the beginning of this paper, I cannot regard this method of treatment as otherwise than extremely risky. Dr. Cobbold is strongly opposed to it on pathological grounds. He says: 'Our object should be not to interfere with, but to promote, Nature's curative efforts. If I read the pathological facts correctly, she seeks to bring about this result by erecting artificial barriers which serve to moderate the bleeding. In this way, under ordinary circumstances, the life of the bearer is sustained, or held in the balance, until the parasites either perish or cease to be capable of causing

active disease. Depend upon it, this is the principle which should guide physicians in their treatment of the Bilharzia disorder If you catheterize and employ medicated injections, you do more harm than good.' Sonsino goes still further, and holds that it would be an error in practice to cause the death of the animal, even if it were possible to do so, since it would be likely to cause embolism as a foreign body, or to generate septicæmia by its decomposition. I would venture to submit, therefore, that the physician's efforts should be rather directed towards the sustaining of the general health of the patient, and the mitigation of any untoward symptoms that may arise, than to any attempt to kill the distoma itself. Especially should he be on the watch for any symptoms of vesical or renal calculus. In the latter case, free diluents may be used with advantage, especially on retiring to rest; and in the event of the urine being acid, the use of the acetate or citrate of potash might be of service in preventing the formation of a uric acid or oxalate of lime calculus.

A nourishing but non-stimulating diet should Diet. be recommended; the patient should eat not much, but often, and avoid heavy wines and protracted dinners. Experience soon teaches him the increased amount of comfort obtained by keeping the urine in a constant state of free dilution, and it

is usually unnecessary to recommend the free imbibition of non-alcoholic drinks.

Prophy-
laxis.

Before leaving this part of the subject, I would say a few words as to the prophylaxis of this disease. Until more is known of the life-history of the *Bilharzia*, much, of course, must be mere guess-work; but the following rules may safely be adhered to with the hope, at any rate, of lessening some of the risks of infection:

1. The water drunk should come as much as possible from deep wells or springs, and all shallow pools of drinking-water should be avoided.

2. All drinking-water should be filtered and boiled.

3. Bathing should not be indulged in, excepting in the sea.

4. Watercress, fresh-water fish of all kinds, and small crustacea, should be avoided.

And, lastly, every *Bilharzia* host should be warned of the possibility of his becoming a source of infection to others.

APPENDIX.

BILHARZIA IN ANIMALS.—FILARIA BANCROFTI.

So long ago as 1857, the Bilharzia was found by Cobbold in *Cercopithecus fuliginosus*, an ape from Africa (? West Coast), which died in the Zoological Gardens, Regent's Park. I am not aware, however, of any case again being recorded as occurring in animals until Sonsino's publication in May, 1876, of his discovery of the parasite in a three-year-old bull. In the portal vein of this animal, which was exposed for sale in a slaughterhouse at Zagazig, he found some thirty-five living specimens of the Bilharzia; and in many cases the females were still lying in the male gynæcophoric canal, appearing like a thread of black silk from each extremity. The males were somewhat broader than those found in the human species, though otherwise there seemed no difference. That the species is quite a distinct one, however, is at once apparent from a consideration of the ova. These are fusiform in shape, with a well-

marked central swelling, and narrow slightly at the poles. The length varies from 1·16 mm. to 0·18 mm., and the transverse diameter from 0·04 mm. to 0·05 mm. The spine is also different, being broadly hastate in shape. When the ovum is lying in the oviduct, the spine-bearing pole is always directed inwards, and never towards the vulval aperture.

Neither free embryos nor embryos within the ova were to be found. The bladder and intestine showed characteristic evidences of the ravages of the parasite. *Fasciola hepatica* was also present in the liver.

The above appear to be the only two cases recorded of the existence of the Bilharzia in animals. Some years ago, however, while in Natal, it had occurred to me that the so-called 'red-water'—a disease very common and fatal among cattle in that country, the leading symptom of which is hæmaturia—might be due to the presence of a parasite; but I had no opportunity of verifying it either by a necropsy or a microscopical examination of the urine. The late Colonial Veterinary Surgeon, Professor Branford, considered that it was caused by indigestion, with subsequent affection of the kidneys; but that this is a theoretical opinion appears from his 'Report on Red-water,' in which he regrets that the animals had not been ex-

amined for hæmatozoa. From his description, however, it would seem that the microscopic appearances of the urine are rather those of hæmatinuria than of true hæmaturia.

Dr. Batho speaks of the Bilharzia being very common in dogs in Natal; and though it is unlikely that the human species is alone singled out for its ravages, I must confess that I have never seen a case, in spite of numerous opportunities.

The *Filaria Bancrofti*, in its embryonic hæmatozoal stage, has been found, in more than one instance, to be co-existent with the Bilharzia in patients suffering from endemic hæmaturia. This circumstance is of the greatest interest as probably explaining the pathology of the type of the disorder prevalent in Mauritius and Réunion. According to Rayer's account, simple hæmaturia is the form under which the malady first shows itself, as has already been quoted. 'At length, after a certain time, several years perhaps, the urine becomes "fatty," "milky," or "chylous." It nevertheless remains more or less tinged with blood, or it may perhaps be alternately hæmaturic and chylous. The malady may last the patient's lifetime without notably impairing the constitution, existing as the hæmaturic form in infancy, and the chylous in adult life.'

*Filaria
Bancrofti*
occasionally
co-existent.

As far as I am aware, it is certainly not usual

for cases of chylous urine to commence in the manner above described ; the hæmaturia being, in the great majority of cases, an altogether subordinate symptom to the chyluria : and I therefore do not think it unlikely that further research will show the trematode and nematode helminths under consideration to be co-existent oftener than has been supposed, especially as the hosts of the latter animal appear very often to suffer but slight inconvenience.

Dr. Sonsino was, I believe, the first to record a case of the occurrence of the *Filaria sanguinis* in a Bilharzia patient. The boy, Morad Daian, a native Jew of fifteen years of age, had been a sufferer from hæmaturia for eighteen months, and was the host of great numbers of the *Oxyuris*, and also of the *Ascaris lumbricoides*. With the exception of deafness and somewhat severe attacks of vomiting, he had no symptoms other than those of an ordinary Bilharzia patient. The urine was not chylous. Sonsino discovered the filaria at the first examination of the blood ; but it is worthy of remark, that at a subsequent search for six successive days, he was unable to find a single specimen. On the seventh day, however, he was again successful. At a later date, Sonsino found filaria in another Bilharzia patient.

In May, 1881, I first examined the blood of the

type case described at the commencement of this paper, and though not successful in the first two or three slides, I eventually discovered a single specimen of the larval filaria, and on the following day, some four or five others. Although I had never before had the opportunity of seeing this minute nematode, I had no difficulty in recognising it from Cobbold's and Sonsino's figures. From the absence of the patient abroad, and various other causes, I was unable to make further examinations of the blood until November; when, to my astonishment, a careful search on five separate evenings was attended by an absolutely negative result. To what to attribute the absence of the filaria, I scarcely know. Sonsino's non-success, above alluded to, may have been owing to the hour at which he examined his patient, as at that time (1874) he must, of course, have been unaware of the nocturnal habits of the hæmatozoon—a possible source of error which was carefully eliminated in my own case—in which the examinations were made at or about midnight. Until a further and more vigorous search can be made, I think that the supposition of the death of the parent worm would be one at which it is hardly safe to arrive.

Discovery of
filaria in
the type
case.

The above is the only instance in which I have examined the blood of a Bilharzia patient.

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